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IMPACT OF (QCEJ) STRATEGY ON DEVELOPING THE SKILLS OF CONSTRUCTING SCIENTIFIC ARGUMENTS AMONG MIDDLE SCHOOL STUDENTS: THE ROLE OF FAMILIARITY WITH SCIENCE CONTENT KNOWLEDGE

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ABSTRACT

This research aims at introducing a new suggested strategy, "QCEJ" strategy, identifying its impact on developing the skills of constructing scientific arguments, and determining the level of scientific argument construction skills among middle school students. Results have shown shortages in the level of argument construction skills in both cases of familiarity and unfamiliarity with science content knowledge and the impact of the "QCEJ" strategy on developing constructing scientific argument skills through teaching a chosen unit entitled "Matter and Energy" for grade (8) students. The study applies important applications in science education in general and scientific argument construction skills in particular.

KEYWORDS: (QCEJ) Strategy, Science Education, Middle School, Argumentation & Argument Construction Skills

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Original Article

INTRODUCTION

Engaging in scientific argumentation is one of the fundamental goals of science education (National research Council [NRC], 2012). It helps students, in science classrooms, to understand reasons, argue claims and extract evidence for their explanations. Students' participation in scientific arguments develops their communication skills, meta-cognitive awareness and critical thinking (Cavagnetto, 2010). It supports their understanding of complex patterns of culture, logical practices of science and scientific literacy in general. Argumentation is essential and desirable in science classrooms because (a) it elaborates meaningful learning by keeping students engaged in cognitive and meta-cognitive processes, (b) it promotes the students' communication skills, and, accordingly, the language practices of science (Cavagnetto, 2010), (c) it externalizes all the students' skills of reasoning and critical thinking, (d) it guides students in analyzing cultural patterns and scientific practices and (e) it fosters scientific literacy (Jimenez-Aleixandre & Erduran, 2007). Students' engagement in the practice of scientific arguments represents an important component of achieving the objectives of scientific literacy (NRC, 1996; Cavagnetto, 2010; Sampson & Clark, 2007; Jimenez- Aleixandre & Erduran, 2007) through the development of critical thinking skills (Kuhn, 1993), which is one of the fundamental aspects of the practice of science (Driver, et al., 2000; Duschl, 2008), and, also, is one of the factors of preparing students for citizenship (Kolsto, 2001). Supporting understanding of the nature and quality of argument among learners is an important component in science education (Osborne, et al., 2001). Argumentation supports students' decision-making skill and their abilities

in dealing with socio-scientific issues (Kheshfe, 2013). Scientific argumentation helps students in classroom on the acquisition and construction of scientific knowledge through critique and discussion (Berland & McNeill, 2010). Also, participation in argumentative scientific discourses increases students' understanding of the social nature of scientific knowledge (Driver et al., 2000; Harlow & Otero, 2004).

Argumentation and Scientific Argument Construction Skills

The literature of argumentation shows a wide range of definitions of the concept in all fields of knowledge. Argumentation in the educational literature is defined by S. Toulmin (1958) as an assertion accompanied by a justification. Accordingly, an argument consists of assertions or claims and their justifications and reasons. In *The Oxford English Dictionary*, there is great emphasis on two basic meanings of an argument. The first is didactic which is described as "advancing a reason for or against a proposition or course of action." Examples of such arguments are familiar in science lessons in which a teacher provides his students with scientific explanations helping them to think and reason certain case. The second meaning is dialogical which involves examining different perspectives in order to argue on acceptable courses of actions. Such dialogical arguments can be negotiated within the individual mind, or among a group (Driver, et al., 2000). (Duschl & Osborne, 2002) indicate that there is a tension between the lay perception of argumentation, and the view of argumentation as a social and collaborative process necessary for solving problems and advancing knowledge. An argument starts with an argumentative claim that represents an explanation of some case, but the entire process of argumentation can't be complete without giving reasons and evidences which support that claim (Berland & McNeill, 2012). The argument is based on two basic components, the first is claimed, and the second is evidence. While the claim is an answer for a question or a problem, evidence is the scientific data which support a claim (Jimenez-Alexander & Erduran, 2007). In science education, students should realize that evidence is some kind of information like observations, speculations and measurements. Evidences, in science classrooms, can be collected by the students themselves if possible or by others and then given to students to evaluate. There is a great difference between data and evidences. Data are the information and measurements that resulted from an investigation. But evidence is a particular subset of data which investigators use in order to support or negate some claim (Liewellyn & Raajesh, 2011). In scientific argumentation, students try to support their claims with evidences. Claims include an answer to a research question (Sampson, et al., 2013). There are numerous amounts of observations, results, data, but evidence is the spatial data which support the suggested claim. In science classrooms, constructing an argument is not a cognitive skill that can be studied, rather it is more difficult than all learning skills (Ryu & Sandoval, 2012). An argument is a collective practice of scientific persuasion and critical thinking through students' interactions with each other in the classroom. Teachers follow students' arguments, making sure that they do interpret data scientifically, and coordinate evidences with claims logically (Sandoval & Millwood, 2005). A science lesson is, thus, turned into a network of claims and the evidences that support it, which, in turn, provides students with a rich scientific atmosphere for learning. In this research, the term "argumentation" refers to the process of argument construction, and the term "argument" refers to the components or skills of constructing the process of argumentation.

Constructing Scientific Arguments in Science Education

The whole body of science consists of pieces of knowledge which are supported by evidences. The work of scientists is mainly based on examining the claims, evidences and justifications of others (NRC, 2012). Constructing an argument is the core process of science, and, by turn, science education. Constructing an argument requires a set of skills

which are essential for being able to engage in argumentation (McDonald & Mc Robbie, 2010). Learning to argue is a group of skills which must be practiced in order to be acquired, because it is, generally, difficult to learn (Ryu & Sandoval, 2012). Students can fail in presenting a correct claim, which leads to their failure in constructing counterarguments (Ryu & Sandoval, 2012). Moreover, they can be unable to set a relationship between data and claims which is called "justification". Justification is particularly the most difficult skill for students in argumentation, and only through instruction, and engaging in certain activities, students can acquire (Clark & Sampson, 2007; Erduran, et al., 2004; Jimenez- Alexander, et al., 2000; Sandoval, 2012). Argumentation activities need open-ended questions that help students to search for various answers. In addition, teachers must provide students with rich set of data, because if data is rich, students' answers will be rich. The data set of an argument can be totally extracted by students, or with the help of their teachers (Berland & McNeill, 2010; NRC, 2012). Skills of argument are making claims, using evidence, and peer review to evaluate claims based on the strength of evidence (Martin & Hand, 2007). There are many projects and institutions of educational reform that focus and emphasize on the skills of scientific argumentation for K-12, such as: Benchmarks for Science Literacy published by the American Association for the Advancement of Science (AAAS, 1993), the NRC`s National Science Education Standards (NSES, 1996), and The Framework for K-12 Science Education prepared by NRC (2012). For example, one of the goals of National Science Education Standards (NSES) (NRC, 1996). The framework for K-12 science education indicates that students should be able to construct a scientific argument showing how data support a claim, realize weaknesses in scientific arguments, appropriate to the students' level of knowledge, and discuss them using reasoning and evidence (NRC, 2012). Notably, we can classify the argumentation skills into three basics: claim, evidence, and justified, which envelope the whole subset skills of argument construction within, as shown in figure 1

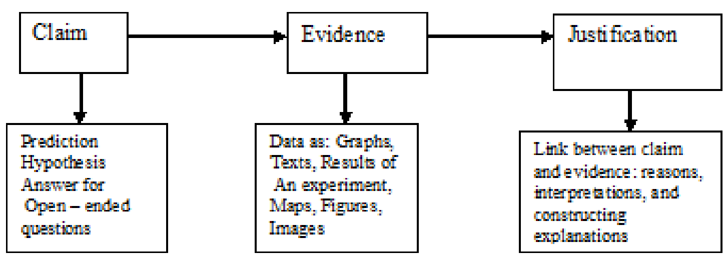

Figure 1: Simple Model of Argument Construction Skills

Familiarity with Science Content and Constructing Arguments

Familiarity with science content knowledge plays an effective role in students' learning. Students come to school with a prior background of knowledge which consists of certain concepts, beliefs and skills. Familiarity with science content knowledge necessitates the simplification of the context that is presented by teachers. The simplification of the instructional context supports the students' argumentation skills, increases their ability to argue new concepts and topics, and improves their written arguments which is usually weaker than their oral ones (Berland & McNeill, 2010). Also, the quality of argument increases, as soon as the instructional context is related to students' prior knowledge, from which they can extract data, warrants and evidences (Osborne, et al., 2004a). Establishing effective content knowledge for an argument is a major element which supports students' familiarity and engagement. Using variable range of sources of data promotes students' familiarity, engagement in argumentation, and critical thinking of evidences. J.D Bransford, et al. (2000) indicates that familiarity allows students to quickly retrieve information and give quick responses to the situation. Thus, the depth of the students' familiarity with the kind of knowledge which is offered to them affects his level of understanding, because

students' abilities to think and solve problems depend strongly on a rich body of knowledge about subject matter. This can take the form of the presence of alternative explanations and theories for certain phenomenon with an emphasis on providing data that helps in determining evidences (Simon & Richardson, 2009). It is found that there is no relationship between students' scientific knowledge and involvement in argumentation, but, generally, argumentation supports learning, and that the selection of scientific context strengthens the scientific argumentation (Eskin, & Bekiroglu, 2009; Simon, & Richardson, 2009). The accurate choice of issues provides an opportunity for the dialogic argumentation (Ascterhan & Schwartz, 2007). Studies declare that the application of the inquiry-based curricula is effective in improving the conceptual understanding, but has no effect upon strengthening the quality of evidence-based reasoning (Hardy, et al. 2010; Change, 2008). Many studies suggest that engaging in argumentation can manage improvement in students' conceptual understanding, if compared with students who are taught by traditional methods (Zohar & Nemet, 2002). Looking at the studies which deal with the effect of familiar and unfamiliar scientific content knowledge and its impact on the level of scientific argumentation skills in students, we find that this dimension is not dealt with in a clear depth. It is recommended by many researchers that we need to explore and define the relationship between understanding of the nature of science (NOS) and skills of scientific argumentation, and we need in particular, to examine the clarity of the relationship between this understanding and argumentation when the issue is more familiar to the students. In addition, the idea of the familiar content needs further exploration and definition. It is, also, important to explore the extent of the students' understanding of argumentation in light of its relationship to the content and context (Kheshfe, 2013).

The "QCEJ" Strategy and Constructing Scientific Arguments

Constructing scientific arguments through introducing evidence is not an easy task. Students can introduce a claim, but they struggle to support it with evidence. Students need help when they try to find evidence that support their ideas during scientific writing and speech. Therefore, students should practice constructing scientific arguments through discussion and through scientific talk and writing practices (Worth, et al., 2009; Fulton & Poelter, 2013). Argument-based evidence is needed by scientists in order to determine the best explanations of scientific phenomena, so defending an idea should be an important component in science teaching and constructing meaning in the classroom (NRC, 2008). Engaging in scientific practices like asking questions, planning and doing investigations, constructing explanations, designing solutions, engaging in constructing arguments from evidence are fundamental practices in science teaching (NRC, 2008). There are many instructional models and teaching strategies for developing scientific argumentation skills. The NSTA introduces two important models for developing these skills: The first is "generating an argument instructional model ". This model is designed to provide small groups of students with a chance to develop a claim through answering a research question using available data. The model consists of five stages; the teacher identifies the task and question, generate a tentative argument, argumentation session is held, followed by the reflective discussion, and final written argument (Sampson, V., & Grooms, J., 2009). The second model is "evaluating alternatives instructional model ". In this model the teacher identifies the task, the research question, and the alternatives, students collect data, generate a tentative argument and counterargument, argumentation session is held, followed by the reflective discussion, and final written argument. The effort of the students in this model appears in determining which alternative explanation is better (Sampson, V., & Grooms, J., 2009). These models use the basic instructional features which introduced in former studies like: (Osborne, et al., 2004b; Sampson, & Clark, 2007). These models suggested by (NSTA, 2016) in a project for biology teaching entitled, "scientific argumentation in biology – 30 classroom activities ", NSTA Press, National science teachers associations. Another template introduced by (Liewellyn, & Rajesh, 2011), consists of (question- claim – evidence – explanation) based

on the first instructional model. This template conducted through analyzing data, determining the claims and writing the explanation. Teachers should change their teaching strategies that are based on traditional inquiry, into the form which helps students to introduce accurate claims supported with evidence and justify it in a clear form and defend it and introduce it to their colleagues in a written and oral form (Liewellyn, & Rajesh, 2011). Also, (Okumus & Unal, 2012) reveal the great effects of argumentation models on students' achievement and managing argumentation skills in science education (Okumus, & Unal, 2012). There are many features of Successful Strategies for Constructing Scientific Arguments as: Social interactions, Open ended questions Language of argumentation such as: claim, evidence, justification, Practice, Cooperative learning, Teacher role (Folton & Poelter, 2013; Heller & Uretsky, 2008; Liewellyn, & Rajesh, 2011). After this demonstration of some teaching strategies and instructional models which aim at developing scientific argumentation skills, the current research presents a proposed vision of the "QCEJ" strategy in four steps as follows in figure 2

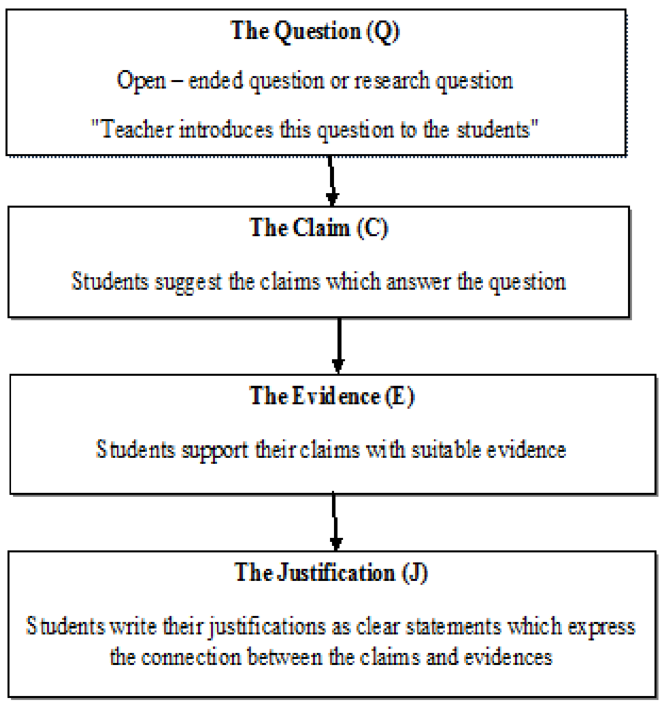

Figure 2: QCEJ Strategy

SUMMARY

The previous studies suggest a relationship between the scientific content knowledge, and the skills of constructing arguments among students. Some studies have suggested that the scientific context and content knowledge help in constructing scientific arguments, while other studies have found no relationship between the two variables. No study attempted to measure the level of the skills of argument construction among middle school students. Also, none explored the relationship between constructing argument skills in its simplest form: claim, evidence, and justification, in both cases of familiarity with scientific content, and unfamiliarity with it. Thus, the research content is different, with the use of a new tool for evaluating the skills of scientific argument construction in the case of familiarity and unfamiliarity with content and context of scientific knowledge. The study starts with adopting a simple scientific topic about "States of

Matter" and, then, turns into more complex topic which is "Polar Bears and Climate Change". The current study aims at determining the level of skills of argument construction, and also tries to promote argumentation skills through developing constructing scientific argument skills.

Supporting scientific argumentation skills is an important goal of all reform projects in science education. Despite its importance and its amount of consideration, the practice of argumentative skills is not familiar in science education (Newton, Driver & Osborne, 1999; NRC, 2007; Osborne & Dillon, 2008; Cavagnetto, 2010). There are no Arabic studies which deal with argument construction skills among middle school students in KSA, so this research tries to explore the level of argumentation skills among students, and to determine the effect of familiarity and unfamiliarity with scientific content knowledge on students' argumentation skills, and also investigate the impact of a suggested teaching strategy " QCEJ" strategy in developing these skills among students.

This Study Tries to Answer the Following Questions

- What is the level of scientific argument construction skills among middle school students in light of familiarity and unfamiliar with science content knowledge?
- What is the relationship between skills of constructing scientific argument in the two cases of familiarity and unfamiliarity with science content knowledge?
- What are the basic techniques of applying the "QCEJ" strategy?
- What is the impact of implementing the "QCEJ" strategy in developing scientific argument construction skills among middle school students in case of familiar and unfamiliar science content knowledge?

METHODOLOGY

Context and Participants

Research consists of two parts: the assessment study and the experimental study. The assessment study was applied to seven schools which are located in two different governorates in KSA, Qunfudah and Mahayel Aseer. The purpose of the assessment study was to determine the level of scientific argument construction skills among middle school students in light of familiarity and unfamiliarity with science content knowledge and the relationship between skills of constructing scientific argument in the two cases. Participants are total of (165) male students from grade (8). The study conducted at the end of first term of 2013/ 2014, immediately after students have finished studying the selected unit. The experimental study applies the basic techniques of using the "QCEJ" strategy in the unit of "Matter and Energy" from the science curriculum of the second year of the middle school in the first term of 2015/2016 which includes three main lessons: “The Matter", "Heat and Conversions of Matter", and "Fluid Behavior", ending with determining the impact of the suggested strategy on developing the skills of constructing scientific arguments.

The QCEJ Strategy Consists of (4) Main Steps as Follows

- **Asking Question (Q):** It is about asking one or many open-ended questions which require finding good claims and right evidences that support claims in order to be answered, and presenting the suitable justification by relating between claim and evidence mainly by using the available data after each question.
- **Presenting Claims(C):** It is a proposed solution for the question asked before, and it is a kind of prediction of the answer of the question.

- **Finding Evidences (E):** It is the data and information which support the claim and a student may get through experimentation or by extracting it from the data presented within tasks.
- **Submitting Justification (J*):*** It is the stage of scientific writing that clarifies the relationship between claims and evidences through a clear process of inference. The open-ended questions that were asked in each lesson as in **(Appendix 1)** and a teacher guide book was prepared in order to illustrate the steps of applying the suggested strategy to the different kinds of lessons, and examined by a group of experts in science education in order to be accredited and legalized **(Appendix 2).**

INSTRUMENTS

The instruments consist of two scientific argument construction skills tests. The first test (Argument1) is based on a familiar science content knowledge **(Appendix 4).** The test consists of two parts, The first part includes information about what makes a material solid, liquid, or gas (Eley, & Price, 2009), The second part is mainly open-ended questions which ask students to classify some materials like water, air, Coca, Cola-pulps, strawberry jam, ice, butter, and jelly into groups each of the same kind. Students should read well, and extract data that can support their claim as evidence, that will help them in providing an appropriate justification for their position. The content of the second test (Argument 2) is part of a study of (Ryu & Sandoval, 2012). It asks students to determine what will happen to the polar bear under the hard circumstances of climate change and to provide the suitable evidence which support their claims. The researcher translated the test into Arabic, and presented to a group of experts in science education in order to be revised and to approve its validity. In addition, an answer sheet is prepared including three questions covering the main three skills of argument construction in **(Appendix 6).** The researcher encoded the levels of answers in both exams using scoring rubric, and it was presented to experts to assure the validity and reliability of coding. The re-coding was repeated after two weeks, and the percentage of difference did not exceed (5%), which is a good proof on reliability (Kheshfe, 2013). The reliability coefficient was (0.87) for the first test and (0.90) for the second test by using Cronbach`s alpha.

Analysis of Argument (1): "States of Matter"

In argument (1), the three components of argument: claim, evidence and justification were analyzed. Claim is a prediction, hypothesis, or an answer for an open-ended question. Evidence is the data which support the claim. Justification is the link between claim and evidence and more in-depth explanation. Scoring rubric for scientific argument construction skills in argument (1) in **(Appendix 3).**

Analysis of Argument (2): "Polar Bear and Climate Change"

For determining the general level of argument construction skills among middle school students, the following question is used as unfamiliar context for students. Scoring rubric for scientific argument construction skills for argument (2) in **(Appendix 5).**

Experimental Design

Researcher adopted the quasi-experimental design. Two groups of preparatory students are chosen from Ahd Bani Zaid School in Qunfudah, one is experimental group consists of (30) students who were taught by the QCEJ Strategy, and the other is control group consists of (30) students who are taught by the traditional way. The lessons using the "QCEJ" strategy were taught and applied to the experimental group. After post- tests, data were analyzed by using the statistical package for social sciences (SPSS).

RESULTS

Results of Assessment Study

Students' Level of Argument Construction Skills

As seen in (table 1) students' level of argument, construction skills is low. The following figure shows percentage of each of the skills of argument (1) and (2) individually:

Table 1: Mean (SD) Scores for Each Component of Argument Construction Test, Argument (1) and Argument (2)

Skill	Argument (1)	Argument (2)
Claim	1.72(0.71)	0.54(0.6)
Evidence	0.9(0.96)	0.27(0.51)
justification	0.24(0.6)	0.12(0.32)
Total	2.87(1.79)	0.93(1.23)

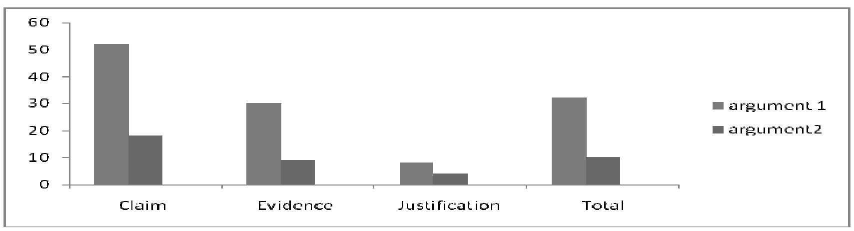

Figure 3: Percentage of Skills of Argument (1) and (2)

Relationship between Skills of Argument (1) and Argument (2)

The Pearson Correlation is carried out to show the correlations between the examined variables of argument (1) and (2). The three argument construction skills: claim, evidence, and justification correlate positively with each other in both arguments.

Table 2: Correlations between the Examined Variables of Argument (1) and Argument (2)

variable	C1	E1	J1	C2	E2	J2
Argument(1)						
C1		0.452**	0.29**	0.487**	0.459**	0.40**
E1			0.453**	0.39**	0.482**	0.51**
J1				0.465**	0.27**	0.31**
Argument(2)						
C2					0.597**	0.431**
E2						0.71**
J2						

**Correlation is clear at the 0.01 level ($p < 0.01$).

Results of the Experimental Study

Pre- and Post-Test For Experimental Group, Argument (1) And (2)

There are significant differences between pre and post test for the experimental group in both argument (1) and argument (2). This result indicates the impact of implementing the suggested strategy "QCEJ" in developing constructing scientific arguments skills.

Table 3: Pre and Post Test for Experimental Group, Argument (1) and Argument (2)

Arguments	Skills	C		E		J		Total		T Value	Df	Sig
		M	SD	M	SD	M	SD	M	SD			
Argument (1)	Post	2.6	0.67	2.3	0.79	1.9	0.84	6.8	2.1	17.5	29	.000
	Pre	0.43	0.50	0.23	0.43	0.06	0.25	0.73	0.98			
Argument (2)	Post	1.9	0.71	1.3	0.46	0.9	0.71	4.1	1.4	15.3	29	.000
	Pre	0.56	0.62	0.30	0.53	0.13	0.34	1.0	1.2			

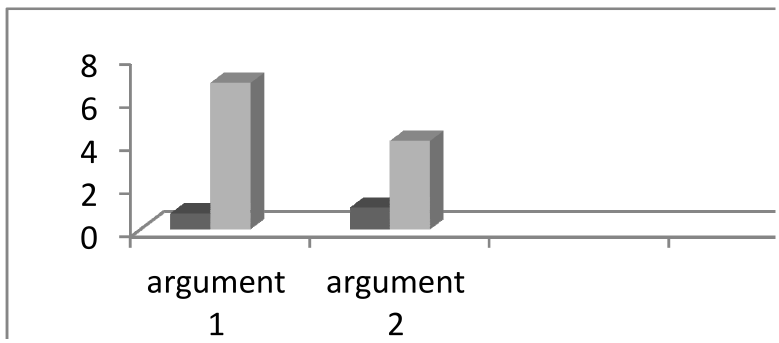

Figure 4: Experimental Group Pre -and Post Test

Differences Between Experimental and Control Group, Argument (1), Argument (2) (Post- Test)

As shown in table (5) there is significant differences between experimental and control group for both argument (1) and argument (2), This result indicates the effectiveness of implementing the suggested strategy "QCEJ" in developing constructing scientific arguments skills.

Table 4: Differences between Experimental and Control Group

Arguments	Skills	C		E		J		Total		T value	df	Sig
		M	SD	M	SD	M	SD	M	SD			
Argument (1)	Exp.	2.6	0.67	2.3	0.79	1.9	0.84	6.8	2.1	10.8	58	(.000)
	Cont.	1.4	0.62	0.76	0.89	0.27	0.63	2.5	1.3			
Argument (2)	Exp.	1.9	0.71	1.3	0.46	0.9	0.71	4.1	1.4	8.5	58	(.000)
	Cont.	0.66	0.60	0.50	0.62	0.13	0.34	1.3	1.02			

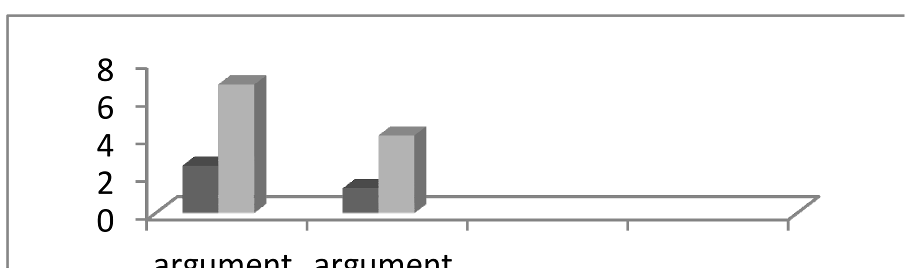

Figure 5: Differences between Experimental and Control Group

Differences Between Performances In Argument (1) And Argument (2): For Experimental Group (Post-Test)

There is significant differences between students' performance in argument (1) and argument (2).

Table 5: Differences between Performances in Argument (1) and (2): for Experimental Group (Post- Test)

Skills	C		E		J		Total		T- Value	df	Sig
Argument	M	SD	M	SD	M	SD	M	SD			
Argument(1)	2.6	0.67	2.3	0.79	1.9	0.84	6.8	2.1	5.7	58	(.000)
Argument (2)	1.9	0.71	1.3	0.46	0.9	0.71	4.1	1.4			

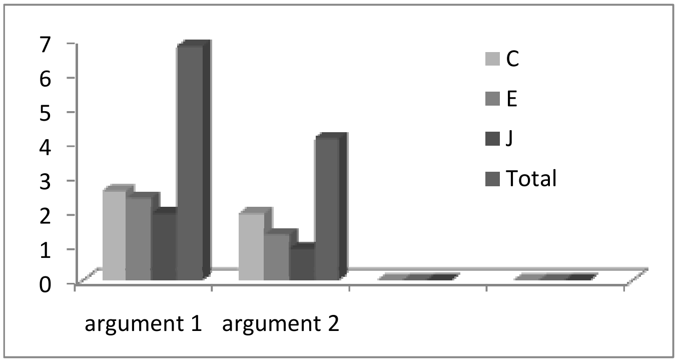

Figure 6: Differences between Arguments (1) and (2) In the Experimental Group in the Post-Test

DISCUSSIONS

The study investigates the impact of a suggested new strategy, (QCEJ) strategy, on developing argument construction skills, and, also, determines the level of scientific argument construction skills among middle school students in (KSA) in case of familiar and unfamiliar science content knowledge. Additionally, the study tries to explore the relationship between the levels of skills in both cases. Reviewing the results shows that the level of students' argument construction skills is low, with both familiar and unfamiliar context and content. This result is consistent with literature showing that students generally have difficulties in argument construction skills (Ryu & Sandoval, 2012; Khishfe, 2013; Driver, et al., 2000; Kuhn, 1993).

None of students is able to complete the justification process. This is consistent with literature showing that, individuals have difficulty in justifying their arguments (Ryu & Sandoval, 2012). Only 52% of participants can make a claim with the familiar science content knowledge. This is consistent with literature viewing that content and context may help in making claims (Berland & McNeill, 2010). Results show that there is a significant relationship between the level of skills of constructing arguments and the case of familiarity or unfamiliarity with science content knowledge. We can say that familiarity with content knowledge facilitates skill learning and performance, and represents the elementary component of the skill. But also**,** Argumentation skills are content free, whenever the skill is mastered, students can perform the task. As long as the argumentation skills have been mastered, the individual can perform them, whether the scientific content is familiar or unfamiliar.

For example, considering the skill of car driving, if the individual has the skill, he or she can drive any car in any place and at any time. Results agree with the findings of previous studies which recommend that there is a relationship between argumentation skills and the familiar and unfamiliar content knowledge. Acquiring the skills of argumentation is a prior requirement for being able to engage in argument (McDonald & McRobbie, 2010). Students must engage in argumentation in order to learn how to do it. Students fail to determine the appropriate warrant which result from relationships between data and claims that is called "justification" process. Justification is a particularly difficult skill for

students; it is the most difficult skill of argumentation, and it can be developed mainly through teacher's instruction (Clark & Sampson, 2007; Eduran, et al., 2004; Jimnez-Aleixandre et al., 2000; Ryu & Sandoval 2012). Results show that there are differences among students' responses to argument construction skills in cases of familiarity and unfamiliarity with science content knowledge. Comparisons between the two cases reveal that the distribution of participants' responses between argument (1) and argument (2) for all skills (claim, evidence, and justification) are significantly different. These results are consistent with (Lewis & Leach, 2006; Sadler & Zeidler, 2005). The more the issue which is presented to students is familiar, the more they can engage in reasoning discussions and scientific arguments. If the scientific context and content knowledge is familiar to students, they will respond positively by active sharing in arguments. Accordingly, misunderstanding of the main topic or issue, because of its complexity or solidity, can lead to failure of reasoning, and, by turn, failure in constructing an argument (Lewis & Leach, 2006). Understanding content knowledge helps students in constructing arguments. Consequently, the lack of this kind of understanding hinders practicing argumentation skills rightly (Sadler & Zeidler, 2005; Sadler & Fowler, 2006). Results indicate that the level of the evidence finding skill is higher than the level of accomplishing the process of justification. These results are consistent with (Berlan & McNeill, 2010) which found that students can provide evidence easier than reason. Also, the level of giving claims has the highest score among other skills of argument construction, which indicates that familiarity with scientific context and content knowledge support and help in the stage of claim constructing more than in evidence and justification accomplishment. In this context, some studies indicate that the elementary level of complexity in the process of scientific argument construction is claim, which represents a direct answer of an asked question (Berlan & McNeill, 2010).

Results of the experimental study show that there are significant differences between pre- and post-tests for the experimental group, and significant differences between experimental and control group in the two tests in the case of familiar and unfamiliar science content. It is an indication of the development of students' constructing scientific argument skills (claim, evidence, and justification). It reveals the impact of using the "QCEJ" Strategy in developing these skills. This result is consistent with literature of study that stresses the importance of the role of engaging students in constructing scientific argument through scientific practices (Folton & Poelter, 2013), and through defending an idea and supporting it with suitable evidence (NRC, 2008), also, through the role of asking open-ended questions and generating a tentative argument (Sampson, & Grooms, 2009; Sampson, & Grooms, 2010). Results indicate that there are significant differences between students' performance in the post-tests of the experimental group in argument (1) (with the familiar science content), and argument (2) (with the unfamiliar science content). These differences reveal that the familiarity with the content enhances the skills of constructing an argument, and emphasizes the importance of the cognitive component in skills learning. In the car driving example, if you have efficient knowledge with car, its parts, and its job, your driving skills will be better. J.D Bransford, et al. (2000) indicate that familiarity allows students to quickly retrieve information and give quick responses to the situation. Thus, the depth of the student’s familiarity with the kind of knowledge which is offered to him affects his level of understanding. Thus, students' abilities to think and solve problems depend strongly on a rich body of knowledge about the subject matter.

CONCLUSIONS

The study introduced a suggested new strategy, (QCEJ) strategy in science education generally, and in scientific argumentation specially. The basic results of the research show the low level of scientific argument construction skills among male middle school students, in both cases of familiarity and unfamiliarity with context and content. Thus, more

researches are needed to explore the level of the same argumentation skills among female students, in other places in KSA, and in other grade levels such as elementary, secondary school, and also at college level. Results show differences between students' responses to familiar and unfamiliar science content knowledge. This emphasizes the role of familiarity with science content knowledge, which necessitates supporting science curriculum with the activities of constructing arguments which, by turn, enables students with the skill of dealing with unfamiliar contexts and complex content knowledge of scientific issues like global warming and climate change (Duschl, & Osborne, 2002). Results reveal shortages in skills of justification; therefore more research is needed to create instructional strategies and curriculum interventions which support this kind of skills. This study does not concentrate on analyzing the nature of the relationship between the level of understanding science content knowledge, and the argumentation skills. More studies are needed to determine the effectiveness of understanding the context and content on the ability to construct an argument. More studies are necessarily needed to analyze the effectiveness of the kind of science content knowledge on argumentation skills. Students must be provided with a body of facts as resources for their arguments. Current studies assert that the process of argumentation is affected by knowing facts about the issues under analysis. And, the more effective factor on argumentation skills is teaching students how to handle those facts, extract claims, find evidences and make justification (Osborne, et al., 2004a; Duscle & Osborne, 2002). The researcher suggests preparing a comprehensive project starts from sixth grade and continues to the third year of middle school for developing argumentation skills among students by the means of supporting scientific argument construction skills, dealing with complex, integrated and global scientific issues. This project requires qualified teachers who are able to improve these skills among students, so the researcher suggests providing training courses for science teachers in middle schools by conducting the previous program. The training course should be long and continuous, since J. Osborne (2013) indicates that the educational intervention of training teachers on the use of instructional interventions strengthens the ability of students' scientific argumentation. Concerning the role of the teacher, the researcher recommends more studies in this field. Teachers should learn how to help students to argue a position using available evidence through using the “QCEJ” strategy. The main task of teachers is teaching students how to argue using available evidences, how to justify them in the scientific process of argumentation, and to provide students with better knowledge of how science actually works. J. Osborne (2013) argue that using argumentation as an educational model makes science education more valuable and the big challenge is, training teachers on how to use it in science classrooms. Finally, In order to implement and develop constructing scientific argument skills, necessary changes must take place in two areas; the first is science curriculum, and the second is the teaching strategies which science teachers adopt in classroom. Concerning the science curriculum, strategic activities should be implemented in order to support the students' abilities of constructing arguments through practicing introducing claims, supporting them with suitable evidences, and then justifying the whole issue. Concerning the teaching strategies, teachers should work hard on helping students to develop their argument construction skills by updating their teaching methods and adopt effective strategies like the (QCEJ) strategy, which is proved to develop the ability of constructing scientific argument, that it is considered a fundamental requirement in the Next Generation Science Standards (NGSS, 2016).

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